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BIOLOGICAL NOTES ON THREE FLORIDIAN WASPS
(Hymenoptera, Sphecidae)

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During the summer of 1962, while both of us were in residence at the Archbold Biological Station, Lake Placid, Florida, we had an opportunity to observe the life history and behavior of a number of solitary wasps. Each of us made observations on three sphecid wasps, *Nitelopterus slossonae* Ashmead, *Tachytes* (*Tachyoides*) *mergus* Fox, and *Oxybelus emarginatum* Say. We have pooled our notes on these, and present joint accounts in order to give a more complete coverage than would be possible in separate contributions.

Our observations were made 5 miles south of Lake Placid on the grounds of the Station, in sandy scrub areas adjacent to Lake Annie, just north of the Station property, at Lake Placid, and at Arcadia, 35 miles west of the Station, on sparsely vegetated sand flats adjacent to and above the Peace River (Fig. 4).

We are grateful to the following specialists for identification of the prey and parasites of the wasps: W. J. Gertsch and W. Ivie, American Museum of Natural History, Araneae; and A. B. Gurney, C. W. Sabrosky and G. C. Steyskal, Entomology Research Division, Orthoptera and Diptera. We are also indebted to H. E. Evans, Museum of Comparative Zoology, for his kindness in allowing us to incorporate some brief field notes on *Tachytes mergus* made by him and C. M. Yoshimoto along Blackjack Creek and on the Medora sand dunes in Kansas in 1952.

Nitelopterus slossonae Ashmead

Our observations were made on a population of typical *slossonae*[1], at Arcadia, and on populations of *slossonae barberi* Krombein[2] at Lake Annie and Lake Placid. Males of the two subspecies are indistinguishable, but females are recognized readily by some slight behavioral traits as detailed below, and by the entirely red abdomen and slightly larger size of *slossonae barberi* as contrasted with the somewhat smaller size and red and black abdomen of typical *slossonae*.

We observed burrow excavation by *s. barberi* only (62462 A, 62562 A, 62762 A, NI-1, 2, 3 and 5). Usually the burrows were begun on slightly sloping areas of open sand, but one nest was started on the side of a pit we had dug to obtain the nest of another wasp, and another was begun in a spoil heap of loose sand 5–6 cm above the adjacent sand. In searching for a place to dig, one wasp made several false starts and finally disappeared without having completed a burrow, and another began a second burrow after making a false start 0.8 cm long elsewhere. The burrows were always begun in loose, dry sand, and the wasps used only the forelegs, working in unison, to excavate. As the sand was thrown backward, the wasp held her wings raised nearly vertically and bobbed her abdomen up and down in synchrony with the action of her forelegs. At intervals, the wasp backed from the burrow and cleared away the loose sand which accumulated in a spoil heap below the burrow entrance. The spoil heap was raked flat as she moved forward to the entrance, throwing sand backward as she went. She kept her wings raised nearly vertically until she entered the burrow, at which time she lowered them over the dorsum of her abdomen. We timed the burrow excavation of three females at 35, 45 and 55 minutes for burrows 2.5 to 4.0 cm in length.

We observed males digging short burrows in the sand with their forelegs, probably to serve as shelters during the rain or for overnight. We are uncertain whether females remain overnight in their nests, or whether they, too, dig a short temporary burrow for shelter.

Immediately upon completion of the burrow the *barberi* females left the entrance open and proceeded to make orientation "tours" over an area 1–2 meters from the entrance. Usually, three or four brief orientation "tours" were made in the immediate vicinity, mostly on foot or in short, low flights, alternating with short visits inside the burrow. The wasps then began to hunt for prey, still leaving the entrance open. Occasionally, the wasp returned without prey several times during the hour, entered her burrow for a few seconds, and then departed for another period of hunting, still leaving the entrance open.

In making the temporary closure, one *barberi* female (62462 B) raked in sand from the spoil heap and then appeared to pound it with the venter

[1] Based on KVK notes 7362 A, C, D, E, 7462 C and E, and FEK notes NI-6, 7, 8, 9 and 11.

[2] Based on KVK notes 62462 A, B, C, 62562 A and 62762 A, and FEK notes NI-1, 2, 3, 4, 5 and 10; observations 62762 A and NI-1 were made on the same individual.

of her abdomen. This element of her behavior needs confirmation by additional observations. The apparent pounding of sand with the abdomen may have actually been just the bobbing up and down of the abdomen, such as we noted during excavation of the burrow and during prey transport. Our observations (62462 A, B) indicate that *barberi* may make a temporary closure nearly an hour after the orientation "tours" and subsequent visits, even though no prey has been brought into the nest. Once typical *slossonae* (7362 C) left her burrow entrance open after placing a spider in the cell; we are uncertain whether this behavior is typical for that subspecies.

Females of both typical *slossonae* and *s. barberi* hunted for prey mostly on the open sand or on or under prostrate vegetation. Most of the hunting was done rapidly, either on foot or in short, "skipping" flights less than a centimeter above the ground surface. Probably the wasps are poor fliers because of the short wings, which explains why so much of the hunting and prey transport is done on foot. While hunting on foot, the wasp held her abdomen upward at an angle and bobbed it up and down, and flicked her wings incessantly. In our experience females of typical *slossonae* held the abdomen at a somewhat lower angle than did those of *barberi*, and the short, "skipping" flights were less rapid. However, these apparent ethological differences may simply reflect variation among individuals we observed, and may not be typical of all females of these subspecies.

We were not fortunate enough to witness capture of the prey. Presumably, it is stung, because the spiders which we recovered from wasps during prey transport or which we found in provisioned burrows were thoroughly paralyzed. Occasionally, one or more of the spiders' legs were missing at the coxal joint. Possibly, the wasp amputated a leg in order to feed on the exuding blood, and not to make transport easier, since only one to four legs were missing on three of the nine spiders used as prey. The possibility should not be overlooked that the few spiders with missing legs may have lost them by some other agency than amputation by the wasp. We took one spider with one missing leg from a wasp during transport, and recovered from partially provisioned nests two others with one or more legs missing.

We observed prey transport by five females of typical *slossonae* (7362 A, D, E and 7462 C, E) and by one of *s. barberi* (NI-10), and could distinguish no behavioral differences. Usually, the wasp walked rapidly over the sand, straddling the spider, but twice we saw females of typical *slossonae* make periodic, low, "skipping" flights with their spiders. The spider was always held venter to venter, head forward, and usually the wasp clutched the forelegs, or a foreleg and a pedipalp of her prey between her mandibles. The wasp bobbed her abdomen up and down rhythmically, while she walked with her spider over the ground. Krombein and Evans (1954: 232) recorded a female of typical *slossonae* transporting her prey

on the ground, and later (1955: 231) noted another female of *s. slossonae* flying with her spider.

We obtained only two specimens of prey from *barberi* (62562 A, NI-10). One was a small (2 mm long) female linyphiid, *Meioneta formica* (Emerton); the other was a large (4.2 mm) immature salticid, *Pellenes* sp. We recovered six spiders from females of typical *slossonae* or from their nests as follows:

7362 A—Linyphiidae, ♀ *Meioneta formica*, 2 mm long (wasp 4 mm)
7362 C—Lycosidae, young *Lycosa* sp., 2 mm long
" Dictynidae, ♀ *Dictyna altamira* Gertsch and Davis, 2 mm long
7362 D—Lycosidae, young *Lycosa* sp., 2.5 mm long (wasp 5 mm)
7362 E—Lycosidae, young *Lycosa* sp., 3.5 mm long
7462 C—Lycosidae, young *Arctosa* sp., 2.8 mm long (wasp 5.5 mm).

None of these spiders is a snare-builder, and it is probable that both subspecies of *slossonae* flush their prey from the bare sand, from prostrate vegetation, or from leaves or other debris on the ground. Krombein and Evans (1954: 232; 1955: 231) recorded two salticids, *Metaphidippus galathea* (Walck.) and *Habrocestum pulex* (Hentz) as prey of typical *slossonae.*

The available data suggest that two or more spiders are stored per cell, but we are uncertain whether there is only one or perhaps more cells per nest. We dug up two nests of *barberi* (62562 A, NI-1); each contained one cell with a single spider but no wasp egg. Krombein and Evans (1955: 231) noted a nest of typical *slossonae* with a single spider but no egg. We dug up another single-celled nest (7362 C) of typical *slossonae* which contained two spiders but no egg. Ferton (1896: 266) recorded 7 to 12 spiders per cell in nests of the European *Miscophus bicolor* Jurine, which genus is very closely related to *Nitelopterus.* He did not mention whether there were one or more cells per nest, so the assumption is that there was only one.

We had only moderate success in tracing the burrow to the cell. Usually, the burrow was in dry sand and frequently led into a mass of fibrous grass roots, so that its course was often lost. We were unable to detect any differences between nests of *barberi* (62462 A, B, 62562 A, NI-1) and of typical *slossonae* (7362 C, NI-11). Usually, the burrows had a diameter of 2 mm, and entered the sand at an angle of 40–45° with the horizontal. They were straight, 2–4 cm long, and ended in a crude cell 1.8–3.5 cm below the sand surface.

We observed final closure by a single female of typical *slossonae* (7462 E). When first observed, this wasp was clutching the anterior end of a spider in her mandibles and was holding the cephalothorax and abdomen of her prey with her fore- and mid-legs. Perhaps she had just stung the spider, or perhaps she assumed this position to malaxate it. Ferton (1896: 267) recorded malaxation of the spider prey to obtain a liquid (blood?)

by two European species of *Miscophus*. Our wasp then carried the spider over the sand for 6 meters, walking most of this distance, but occasionally making short, low flights. We lost sight of the wasp just before she entered the burrow head-first with the spider at 1447 hours. We do not know whether there had been a temporary closure at the entrance. Seventeen minutes later she came out of the burrow head-first, crawled around for a few seconds, and then began to make a permanent closure. She threw sand backwards from the spoil heap toward the burrow, gradually backing up, and raking it down into the burrow with her forelegs. She continued this for 2 or 3 minutes and then began to pull down sand with her mandibles from the overhanging upper edge of the entrance, and to pack it into the burrow. She completed filling the burrow at 1508, but 15 minutes later was still smoothing sand for a distance of 3–5 cm over and around the entrance. She did not pound the sand with her abdomen either while filling the burrow or subsequently smoothing over the entrance and surrounding area. Neither did she bob her abdomen as she raked sand backward, keeping her wings folded flat over her abdomen. We scared her away when we attempted to capture her at 1523, and unfortunately lost her nest due to the dry shifting sand and interspersed grass roots.

Tachytes (*Tachyoides*) *mergus* Fox[1]

This is the only valid, described species in the United States belonging to this distinctive subgenus; as compared with *Tachytes* of other subgenera, *mergus* is peculiar in having two strong teeth on either side of the median lobe of the clypeus, more slender mandibles, and very sparse decumbent setae on the pygidium. Presumably, the distinctive characters of the clypeus and mandibles are related to the unusual (for the genus) way in which it digs its burrow. *T. mergus* ranges from New Jersey and Nebraska southward through Central and South America to Brazil. For so widely distributed a wasp there is a surprising lack of published biological data. The only previous life-history note is by Williams (1928: 53–54).

Most of our *mergus* nests were either near water, or in sand having a high water table. This apparent preference for sandy areas near the water's edge was noted earlier by Williams (1913: 198) in Kansas and by Krombein (1953: 281) in North Carolina.

We observed various aspects of the excavation of the nesting burrow by six wasps (63062 B, 7362 B, TY 4, 8, 9, 14). All of the nests were begun on a flat or slightly sloping surface, except for one started in the side of an impressed heel print and one on a 45° slope of a sand pile on a concrete platform. When discovered, the wasps had already been at work on these burrows, so we have no information on selection of a nesting site.

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[1] Based on KVK notes 63062 B and 7362 B, and FEK notes TY 1, 2, 3, 4, 6, 7, 8, 9, 13, and 14, made at Archbold Biological Station, Lake Annie, Lake Placid and Arcadia sites. We have also incorporated some data from notes made by H. E. Evans and C. M. Yoshimoto in Kansas, HEE notes 60, 64, 87, 96, 113 and 199, and CMY note 74.

PLATE I. *Tachytes mergus* Fox. Fig. 1, burrow profile (*c*, cell; *e*, entrance), nest 63062 B, July 1962, × 0.54. Fig. 2, burrow entrance (*e*) and excavated sand pellets, nest TY-4, 2 July 1962, × 0.50. (Both figures by KVK.)

Four of the burrows were marked by a roughly crescentic spoil heap of large lumps of damp sand 2–8 cm from the burrow entrance (Fig. 2). A fifth burrow begun on a 45° slope had a reniform spoil heap of large pellets 2–6 cm from the entrance. The crescent-shaped spoil heap was usually about 3 cm wide in the middle and about 0.5 cm high. Evans observed similar disposition of the excavated pellets in Kansas.

The behavior during digging was quite consistent in the several individuals observed. In the early stages of the excavation, where the sand may be finer and less damp, the wasp used her forelegs to fling the sand beneath and a few centimeters behind her. Evans also observed this behavior early in the burrow excavation. Later, when she reached the damper, more coarse sand, she backed out of the burrow, carrying a formed pellet 2–3 mm in diameter between her mandibles and forelegs. Evans observed this pellet being formed by the mandibles and forelegs. The forelegs were bent upward to form a sort of basket with the mandibles, as was observed also by Williams (1928: 54). She then walked backward several centimeters and dropped the sand pellet on the spoil heap. Her wings were kept folded flat over the dorsum of her abdomen and her antennae extended downward and slightly outward while she walked to and from the spoil heap. Her actions were rapid but not at all nervous. Occasionally, the wasp backed away from the entrance and cleaned her antennae and rubbed her hind legs against the sides of the abdomen. One female was troubled twice by a small, red ant while she was digging. Each time, she chased it off with threatening motions, deserting the burrow for sometimes as long as 5 minutes. Females of *mergus* were also frequently troubled by miltogrammine flies while digging. The latter were usually chased off and immediately thereafter the wasps resumed digging. Females worked very diligently, one bringing out as many as 6 or 7 loads of sand a minute during an early stage of her excavation. Later, as the burrow grew deeper, the wasp brought out loads of sand less frequently.

The excavation of nearly the entire burrow was observed only once (63062 B). It was estimated, from the size of the spoil heap at 1045, when the burrow was discovered, that the wasp had already been digging for about 20 minutes. At 1145 she made a temporary closure from within with several large pellets of damp sand. It is assumed that the making of this closure marked the completion of the burrow, for the wasp did not reappear for another hour. At 1245 she exited from the burrow headfirst, walked over to the spoil heap, and then reentered her burrow, throwing up another temporary closure in the entrance. It seems unlikely that any digging was done from 1145 to 1245, for no sand was brought out nor was there a large accumulation of loose sand in the empty burrow when it was dug up several days later. These data indicate that excavation of a burrow requires somewhat more than an hour, but that the wasp does not necessarily begin hunting prey immediately thereafter.

Presumably, when the wasp is ready to provision a cell, she temporarily closes the burrow entrance. At least such a closure is maintained between

provisioning flights and consists of a few scuffs of loose sand thrown backwards with the forelegs into the burrow. One wasp did not even reach the sand surface before she began making the temporary closure while still within the entrance. It seems likely that the wasp also makes some sort of orientation flight after completing the burrow and prior to hunting prey, but we did not observe such a flight.

Prey consisted of pigmy mole crickets belonging to two tridactylid species, *Tridactylus apicalis* Say and *T. minutus* Scudder. Williams (1928: 54) also found *mergus* preying on *Tridactylus,* probably *apicalis* Say, in Brazil. His earlier guess (1913: 198) that it probably preyed on immature Tettiginae in Kansas was certainly erroneous. Evans captured a female *mergus* in Kansas flying with a paralyzed *apicalis* adult. In our experience most of the prey were immature, but there were a few adults. The specimens we preserved consisted of 12 nymphs of *apicalis,* 3.8–6.0 mm long, and 2 adults of *minutus,* 3.5–4.8 mm long. The only other wasp which is known to prey on pygmy mole crickets is *Tachytes* (*Tachynana*) *minutus* Rohwer. Previously unpublished observations at Plummers Island, Maryland (by KVK), and at the Archbold Biological Station, Lake Placid, Florida, and at Auburn, New York (by FEK), establish that *Tachytes minutus* also uses *Tridactylus apicalis* Say as prey.

In hunting for prey the wasps made short, rapid flights about 3–4 cm above the surface of the sand, interspersed with equally rapid, short, zigzag walks on the sand. Frequently, the wasp paused on the sand, tapping the surface rapidly with the outstretched distal segments of its antennae. When the wasp finally located a hidden pygmy mole cricket, sometimes only after some 20 minutes of hunting, she began to dig for it, using her mandibles to loosen large pellets of sand. These pellets were carried backward very rapidly and deposited 1–2 cm from the excavation. One hunting female (TY 1), at intervals, turned in a rapid circle on one side or the other of its excavation. These circles were made every few seconds at the start, but the intervals became longer as the excavation deepened. This female dug downward from 0.8 to 4.2 cm to reach her prey (based on three observations). When the wasp reached the *Tridactylus,* she pulled it rapidly out of its burrow, clutching its head in her mandibles. She then flew a short distance, landed on the sand surface and, holding the prey beneath her, stung it. In 1–3 seconds, she flew off, usually at a higher level than when hunting. During flight, the wasp held the cricket with all six legs. Usually, the prey was carried venter up and head forward, but once the wasp carried the cricket to its nest dorsum up and head forward. One female (TY 3) brought in prey at 1345 and then subsequent crickets at 1420, 1425, 1428, 1435, and 1447. She landed with prey at the nest entrance, holding the sides of the cricket's head with her third pair of legs while she raked open the temporary closure with her forelegs. The cricket was venter up, its body extending beyond that of the wasp. On two other occasions, this same female used her mandibles as well as her forelegs in opening the temporary closure. Usually the wasp remained

inside for only a few seconds, just long enough to place the cricket in the prepared cell.

H. E. Evans has a brief note made by C. M. Yoshimoto as to prey capture in Kansas. Yoshimoto observed the *mergus* locate a nymph a couple of millimeters below the surface, fly into the air with it, and sting it during flight. The wasp alighted on the sand seconds later, and stung the prey again in the thoracic sternum.

The final closure of the burrow after complete provisioning of the nest was observed twice (TY 3, 6). One of the wasps (TY 3) made a temporary closure from within at 1448 after bringing in five mole crickets in a period of 27 minutes. Presumably this closure was made so that oviposition and closure of the cell could be effected. At 1507 this female made an elaborate final closure which ended with her throwing sand with her forelegs from various directions, followed by a few hovering flights and then more leveling of sand over the entrance. In the other observation (TY 6) the entire closure took 25–30 minutes. The wasp first made a closure from within, then opened the closure and appeared headfirst in the entrance; she came out onto the sand surface, began picking up large pellets of sand from the spoil heap in her mandibles and, transferring these to the forelegs, threw them backward into the burrow. As the sand grains accumulated inside the entrance, the wasp raked these with her forelegs, while backing down into the burrow, nearly out of sight. When the upper part of the burrow was filled to the ground level, the wasp came onto the sand surface and threw loose sand backwards with her forelegs over the area of the entrance. After 30 seconds she made a few hovering flights above the area of the entrance and was then captured.

We dug up eight burrows (63062 B, 7362 B, TY 3, 4, 6, 8, 9, 14), but five of them had been abandoned by the wasps before completion, and a sixth was abandoned after completion but before any prey had been stored within. This latter nest (63062 B) demonstrates the normal burrow profile (Fig. 1). The initial section is about 2.5 cm long, and enters the sand at a rather shallow angle; the burrow then turns sharply downward at an angle of about 85° for 11 cm, and ends in a horizontal cell 15 mm long and 7.5 mm high, 12.5 cm below the sand surface. One nest dug up by Evans in Kansas had an initial section 10 cm long entering the sand at a 40° angle, and then a vertical section ending 19 cm below the surface. Another partially completed burrow dug up by Evans in Kansas was in a sloping sand bank; it went in at a steep angle for about 9 cm, then at a shallower angle for 9 cm more, and ended about 25 cm below the surface. Our five partially completed burrows all had an initial section 2–5 cm long at a shallow angle of 25–40° and then the burrow turned downward sharply, ending blindly 5–8 cm below the surface where each of the wasps encountered clay or extremely hard-packed sand which apparently discouraged further digging. Ordinarily, the burrow entrance was 4.5–5.5 mm in diameter, and the burrow itself about 4.5 mm.

One completed nest (TY 3), whose final closure had been observed on

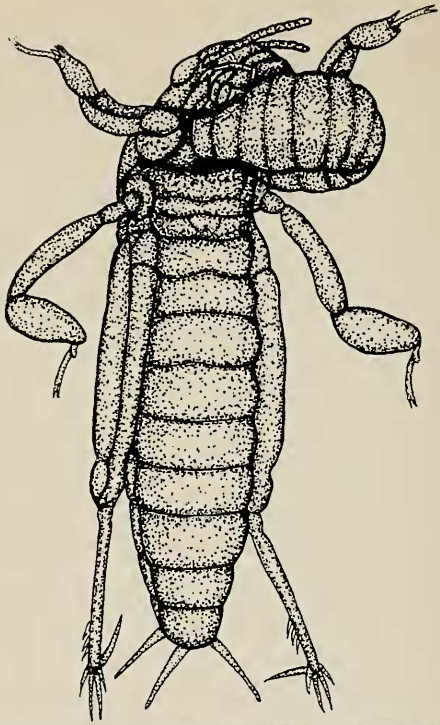

PLATE II. Fig. 3, young larva of *Tachytes mergus* Fox feeding on *Tridactylus* nymph. Fig. 4, sand flats adjacent to Peace River, Arcadia, Fla.; *Tachytes mergus* nested in foreground, *Nitelopterus s. slossonae* Ashm. on sloping bank above river in center. (Fig. 3 by FEK, Fig. 4 by KVK.)

29 June, was dug up on 3 July. The main burrow began at a shallow angle for several centimeters, and then went downward at a very steep angle. The oldest cell, containing a wasp larva about half-grown and eight remaining *Tridactylus*, was at a depth of 16.4 cm. A second cell, containing a smaller larva and 13 mole crickets, was located about 1.5 cm from cell 1 at a depth of 15.6 cm. The last cell, which held a very recently hatched larva and six mole crickets, was 13.5 cm deep, about 4 cm from and on the other side of cell 1. Cells 1 and 2 were 19 cm from the entrance, and cell 3 was 15.5 cm from the burrow entrance.

The final closure of the other completed nest (TY 6) was made on 6 July, and the nest was dug up the next day. It was in an abandoned sand-pile on a concrete platform, and differed in several respects from nests dug in a more normal site. The sand had an angle of 45° where the wasp commenced digging. The burrow itself was 15.5 cm long, and the vertical distance to the cell was only 12.6 cm. There was only a single cell directly on the concrete surface. It contained the wasp egg, six *apicalis* nymphs, and two *minutus* adults. This wasp may have stored only a single cell because of the shallow depth of the first cell.

Williams' observations (1928: 54) on the burrow length are not at all concordant with ours. He found only a "rather short sloping burrow." He also noted that the "nest seems to be a single-celled affair."

All prey were placed in the cells head inward, but either venter up, venter down, or on their sides. Prey taken from the cells were only lightly, if at all, paralyzed and some could jump 15–20 cm into the air. Williams (1928: 54) also noted this very active behavior by released prey, and surmised that the anterior (digging) legs must have been paralyzed or the crickets would have been able to dig their way out of the cell.

The egg is white, sausage-shaped, 2 mm long, and 0.4 mm in diameter. In the one example noted, it was attached at the base of the right fore coxa of the cricket and extended transversely across the thorax. The newly hatched *mergus* larva begins to feed in the soft intersegmental membrane behind the fore coxa with its body extending transversely across the thorax between the fore and mid coxae (Fig. 3). We did not obtain precise data on the duration of the egg and larval stages. Rather fragmentary data indicate that the larva may hatch in 2–3 days, and that the larval stage may last 5–6 days. We preserved the few mature larvae for taxonomic study, so have no information on the cocoon or duration of time between spinning the cocoon and emergence of the adult. Williams (1928: 54) stated that the cocoon is "cylindrical and rounded at both ends and composed of grains of sand glued and spun together to form a rigid cask."

As mentioned above, *mergus* is frequently attended by miltogrammine flies during excavation of her burrow, particularly by *Phrosinella fulvicornis* (Coq.). We observed and captured these parasitic flies during three excavations (63062 B, 7362 B, TY 9), but never saw any flies trailing a wasp with prey, or lurking at the burrow entrance when the wasp entered

with its prey. A specimen of *Phrosinella* was captured after it entered the burrow trailing behind the wasp during one excavation (63062 B), and a second *Phrosinella* was taken as it investigated the temporary closure of this burrow while the wasp was still inside. During another excavation (TY 9) three flies, one of which was a *Phrosinella,* hovered over the female wasp and constantly forced her to interrupt her digging and fly to a plant nearby; the other two flies were identified as *Gymnoprosopa* sp. near *filipalpus* Allen, and *Senotainia* sp. possibly of the *trilineata* complex. After capturing these, a fourth miltogrammine came upon the scene. Still another *Phrosinella fulvicornis* hovered above a third wasp (7362 B) as she dug in the sand, and afterwards, sat watching on a plant nearby.

The frequency with which *Phrosinella fulvicornis* observed the wasps excavating their burrows, its audacity in investigating the burrow entrance while the wasp was inside digging, and its absence from the area of the burrow entrance while the wasp brought in prey, suggest to us the possibility that this fly may customarily deposit larvae or eggs in the burrow entrance before any prey are stored in the nest. One of us (FEK) observed this fly at Groton, New York, sitting motionless on the sand surface while nearby a female *Tachysphex terminatus* (Smith) excavated its burrow. Allen (1926: 73), quoting J. B. Parker, mentioned that *fulvicornis* wanders "about over the sand apparently engaged in smelling, and then digging in the sand." One female dug a small pit at the entrance of an *Oxybelus emarginatum* burrow and then apparently oviposited or larviposited. Allen did not record *fulvicornis* trailing wasps, as he did other genera of Miltogrammini. The lack of specially enlarged compound eye facets might indicate that *fulvicornis* does not shadow its host.

Oxybelus emarginatum Say

This is another widely distributed wasp which occurs transcontinentally in southern Canada and the United States, ranging even into many inland areas of Mexico. Females of this species show considerable variation in size, ranging from 3 to 5.5 mm long. Our observations[1] were made at Lake Annie and Arcadia, and were essentially fragmentary. However, few biological data have been published on the North American species of *Oxybelus* and nothing on *emarginatum.* Since the latter differs from many U. S. species in some essential behavioral details, we feel that our limited data will be illuminating.

Some details of the burrow excavation were noted only once (62562 B). This female was digging her burrow, which entered a gentle slope of sand at almost right angles, standing practically on her head, and flinging the sand beneath and behind her rapidly with her forelegs. All the while, the digging female was shadowed by an unnamed miltogrammine fly. During our subsequent excavation, we were unable to trace this nest because of the constant shifting of the dry sand under the trowel.

[1] Based on KVK notes 62562 B, 62562 C and 62762 C, and FEK note OX-11.

A second, rather large female (62562 C), 5.5 mm long, was observed at 1434 as she flew out of her burrow, leaving the entrance open. She returned in flight 2 minutes later carrying a paralyzed fly underneath, and darted immediately into the open burrow without landing on the sand near the entrance. She flew out of the burrow at 1443, again leaving the entrance open and returned in flight 3 minutes later, presumably with a fly, but darted into her burrow so quickly and close to the ground that we could not see whether she was actually carrying prey. At 1450 she pushed up some sand from below, closing the entrance. Presumably oviposition and/or closure of the provisioned cell took place during the next 12 minutes, as there was no change in the appearance of the burrow entrance. However, when we returned at 1517, a permanent closure had been made.

This burrow, begun in a heel print on a 20° slope, went approximately straight downward. There was a small crescent of excavated sand about 3 mm high extending downhill about 10 mm from the burrow entrance. We found a single cell 3.8 cm below the area of the heel print, slightly to one side. It contained four stocky, female muscid flies, *Atherigona orientalis* Schiner, 3.1–3.5 mm long. The sausage-shaped wasp egg, 1.8 mm long and 0.5 mm wide, was attached upright to one of the flies on the left side between the head and left foreleg. The flies were paralyzed and could move only the legs and proboscis weakly.

We observed a third female (62762 C and OX-11) nesting just below the sand surface in the side of an abandoned pit, which one of us had dug to obtain the nest of a *Cerceris*. This female, smaller than the one reported above, only 5 mm long, was captured flying toward her open burrow entrance carrying a slender, paralyzed cecidomyiid midge, *Anarete buscki* (Felt), 1.6 mm long, beneath her. This nest could not be traced because of the dry, shifting sand.

O. emarginatum is the second Nearctic species of this genus which has been found not carrying its prey impaled on the sting. In the North American fauna only *sericeum*, both typical *sericeum* Robertson (Bohart and Marsh, 1960: 116, 118) and *s. crocatum* Krombein (1955: 74), which belongs to a quite different species group from *emarginatum*, is also known to carry the prey beneath the body. In the other North American species for which biological notes have been recorded, the prey is always carried impaled on the sting whether in flight or on the ground. None of the flies, recovered from our nests nor from wasps in flight, showed any signs of having been impaled on the sting. Another unusual facet of the behavior of *emarginatum* is that it is not known to make a temporary closure of its burrow entrance when it departs to hunt flies. This behavioral trait may be linked to its unusual type of prey carriage, for some species which impale their prey on the sting are also known to make temporary burrow closures which they open with their forelegs without relinquishing the prey. Ferton (1902: 517) also postulated this correlation with some species of Palaearctic *Oxybelus*.

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